LSNReviews

From: Bobby Pabalan [rpabalan@swri.edu]
Sent: Wednesday, October 11, 2006 5:43 PM
To: darrell.dunn@swri.org
Cc: Yi-Ming Pan; xihua.he@swri.org; Lietai Yang
Subject: RE: MRS presentation
Attachments: Dunn MRS 2006 viewgraphs revised by RTP.ppt

Darrell,

attached is a revised Powerpoint file.

bobby

-----Original Message-----
From: Darrell Dunn [mailto:darrell.dunn@swri.org]
Sent: Tuesday, October 10, 2006 10:42 AM
To: Janie Gonzalez
Cc: 'Yiming Pan'; xihua.he@swri.org; 'Lietai Yang'; 'Roberto T Pabalan'
Subject: MRS presentation

Attached file. I included some localized corrosion stuff from the previous MRS paper and Xihua's NACE paper to complete the background. I may not have time to show all of it.

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Properties Page

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From: Bobby Pabalan <rpabalan@swri.edu>
Subject: RE: MRS presentation
In-reply-to: <009f01c6ec82$9522fe80$10b9a281@div18.swri.edu>
To: darrell.dunn@swri.org
Cc: 'Yiming Pan' <ypan@cnwra.swri.edu>, xihua.he@swri.org,
'Lietai Yang' <ltyang@cnwra.swri.edu>
Reply-to: rpabalan@swri.edu
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EVOLUTION OF CHEMISTRY AND ITS EFFECTS ON THE CORROSION OF ENGINEERED BARRIER MATERIALS

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[1]Center for Nuclear Waste Regulatory Analyses
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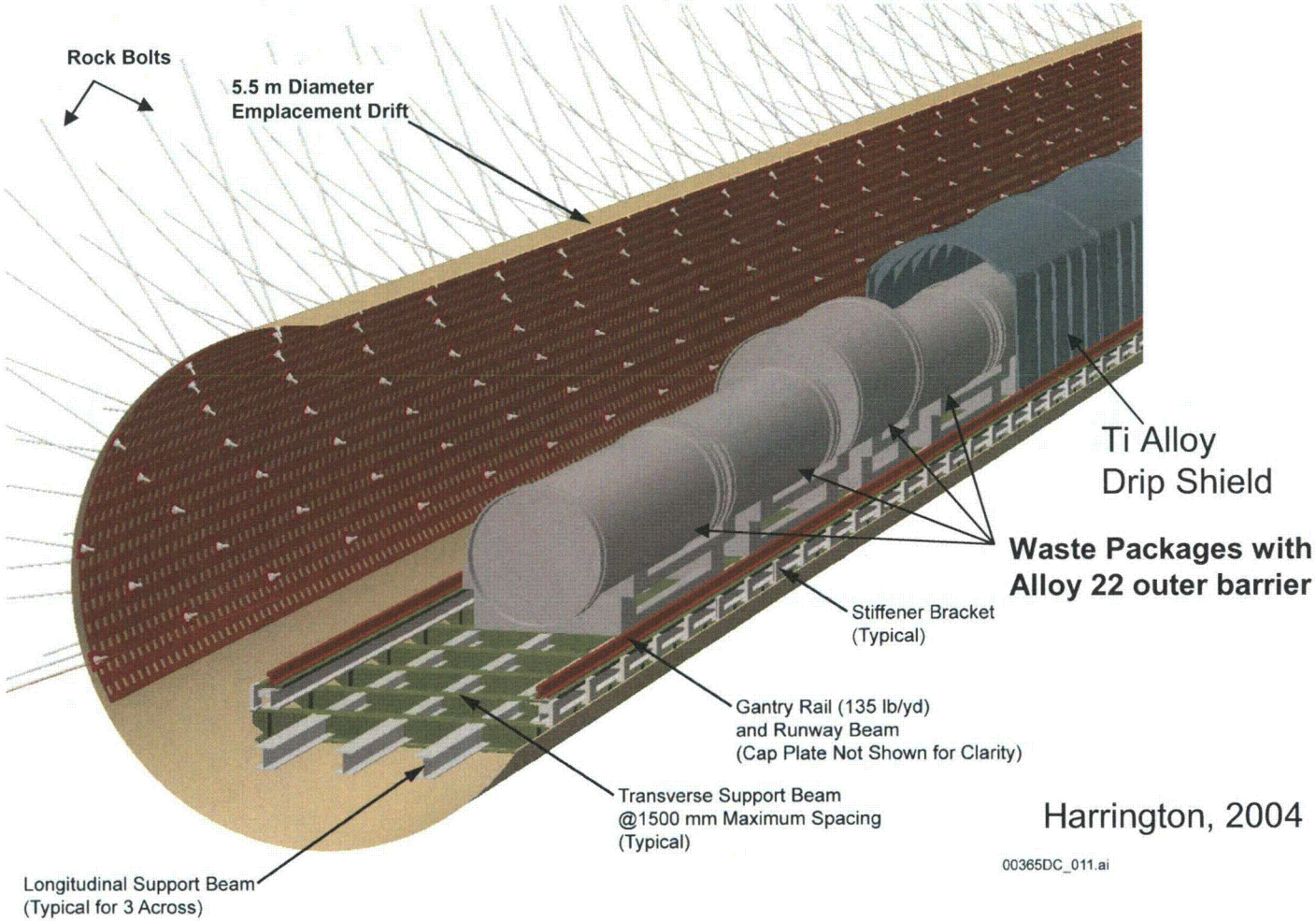
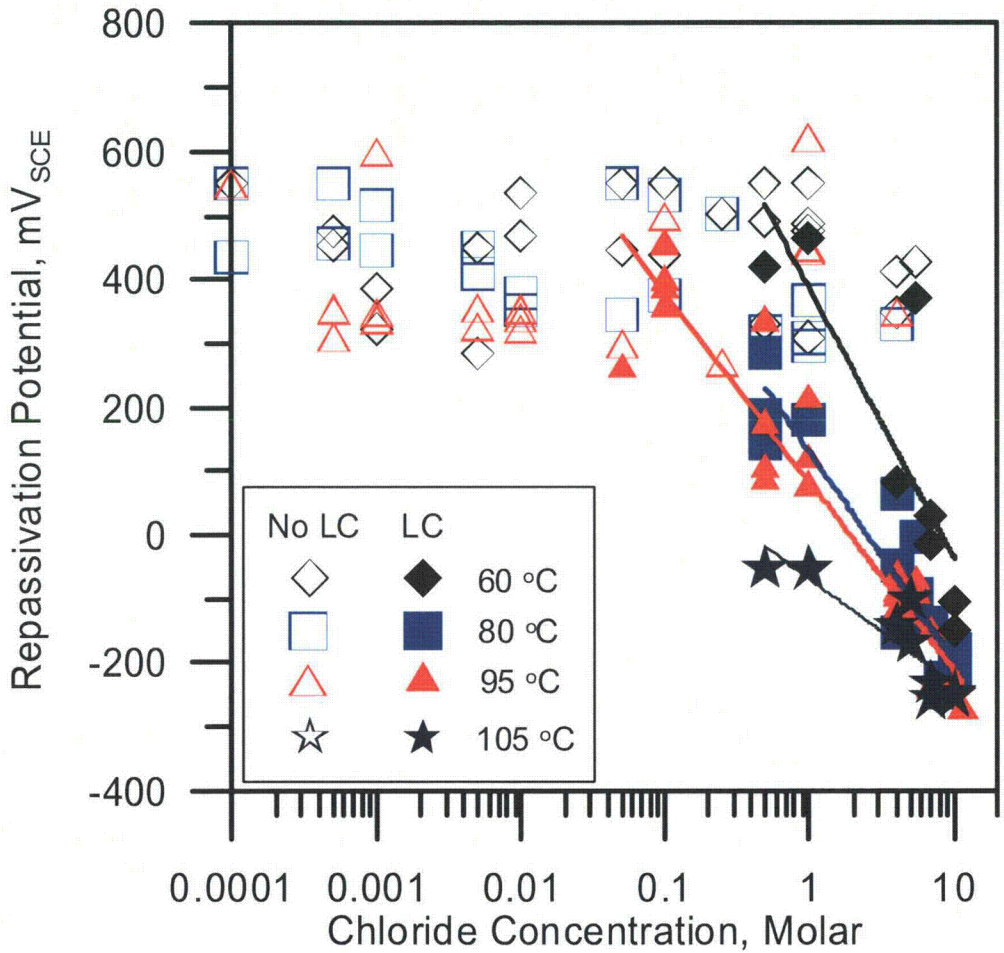
San Antonio, TX 78238-5166

Drift Emplacement



Harrington, 2004

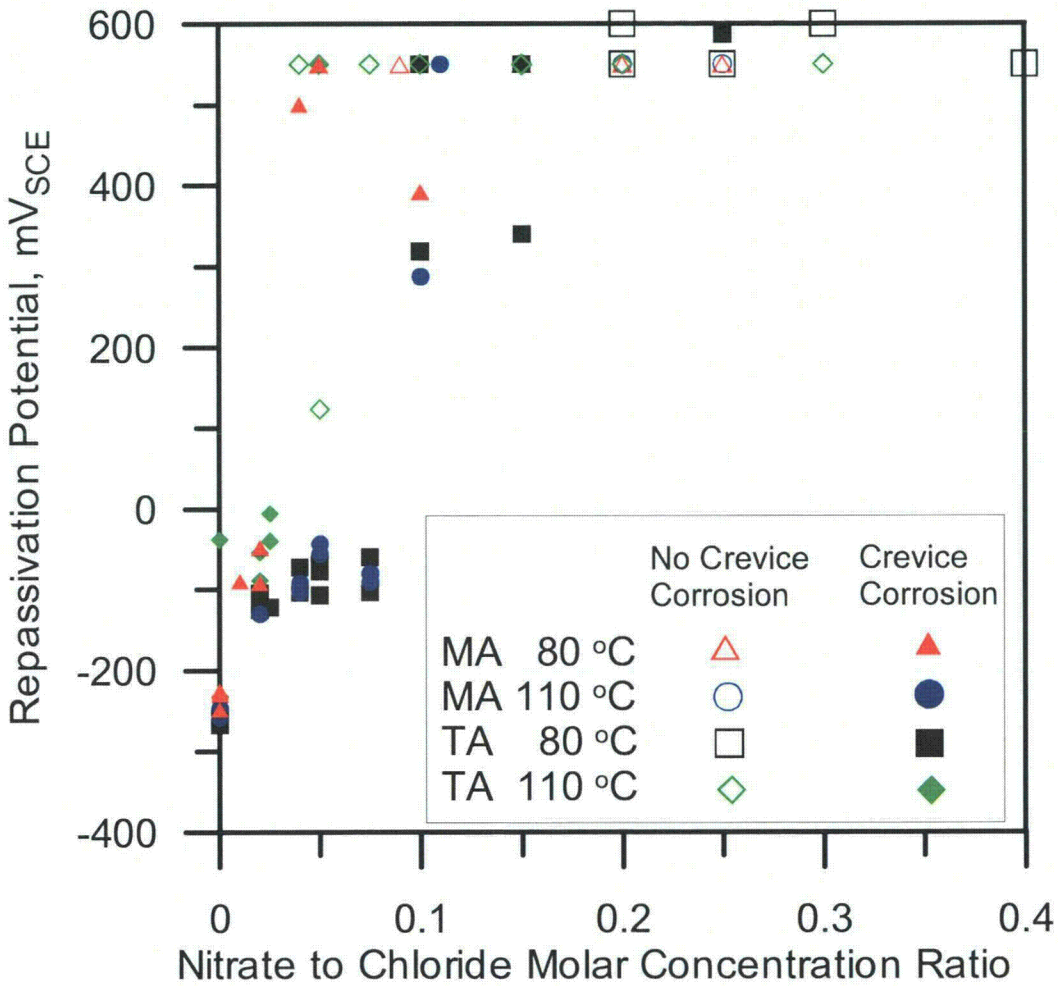
Localized Corrosion Susceptibility



- Localized corrosion susceptibility increases with temperature, chloride concentration, and anodic potentials

Dunn et al. (2005)

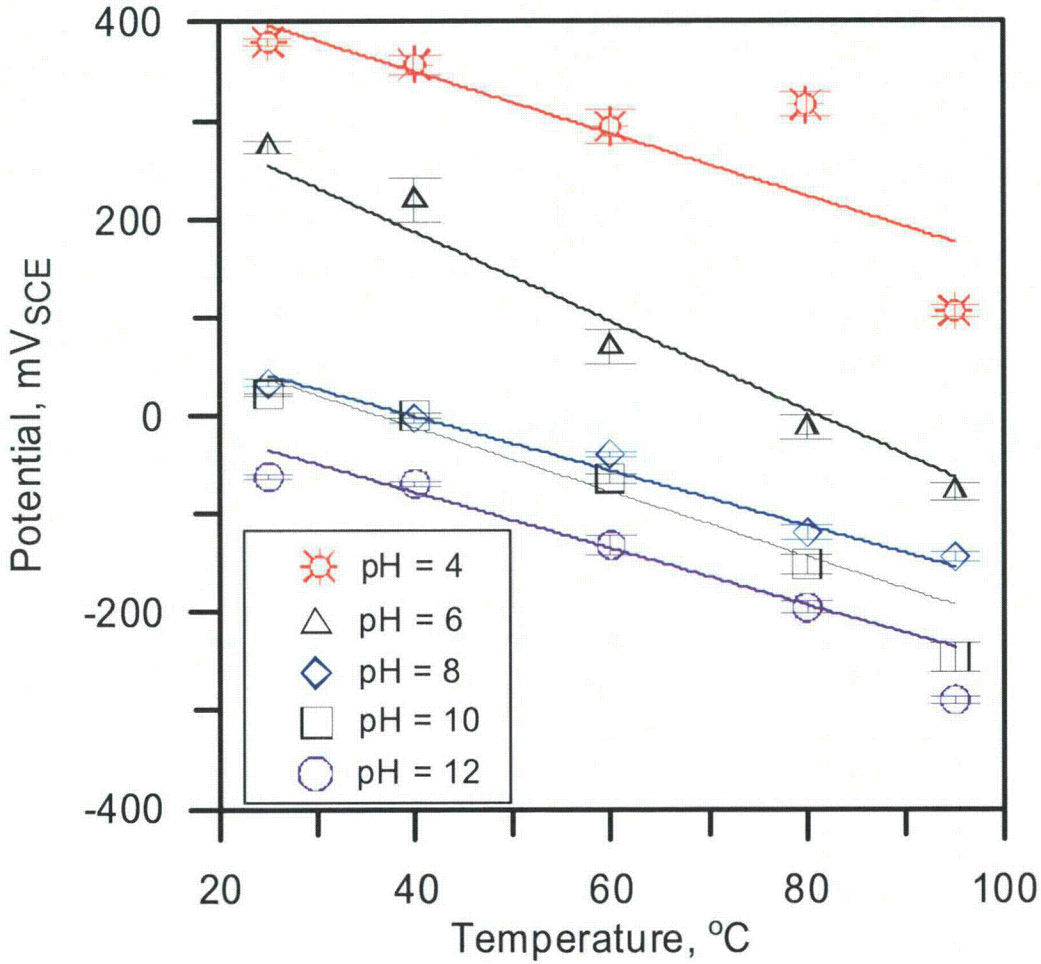
Effect of Inhibitors



- Localized corrosion inhibited at nitrate to chloride molar concentration ratios > 0.1
- Sulfate, carbonate, and bicarbonate also act as inhibitors

He et al. (2006)

Corrosion Potential



- Anodic potentials necessary for the initiation of localized corrosion only observed in acidic solitions

Objectives

- Evaluate the evolution of environmental conditions on the engineered barrier surfaces
- Determine the effects of environmental conditions on the performance of the waste package outer container

Approach

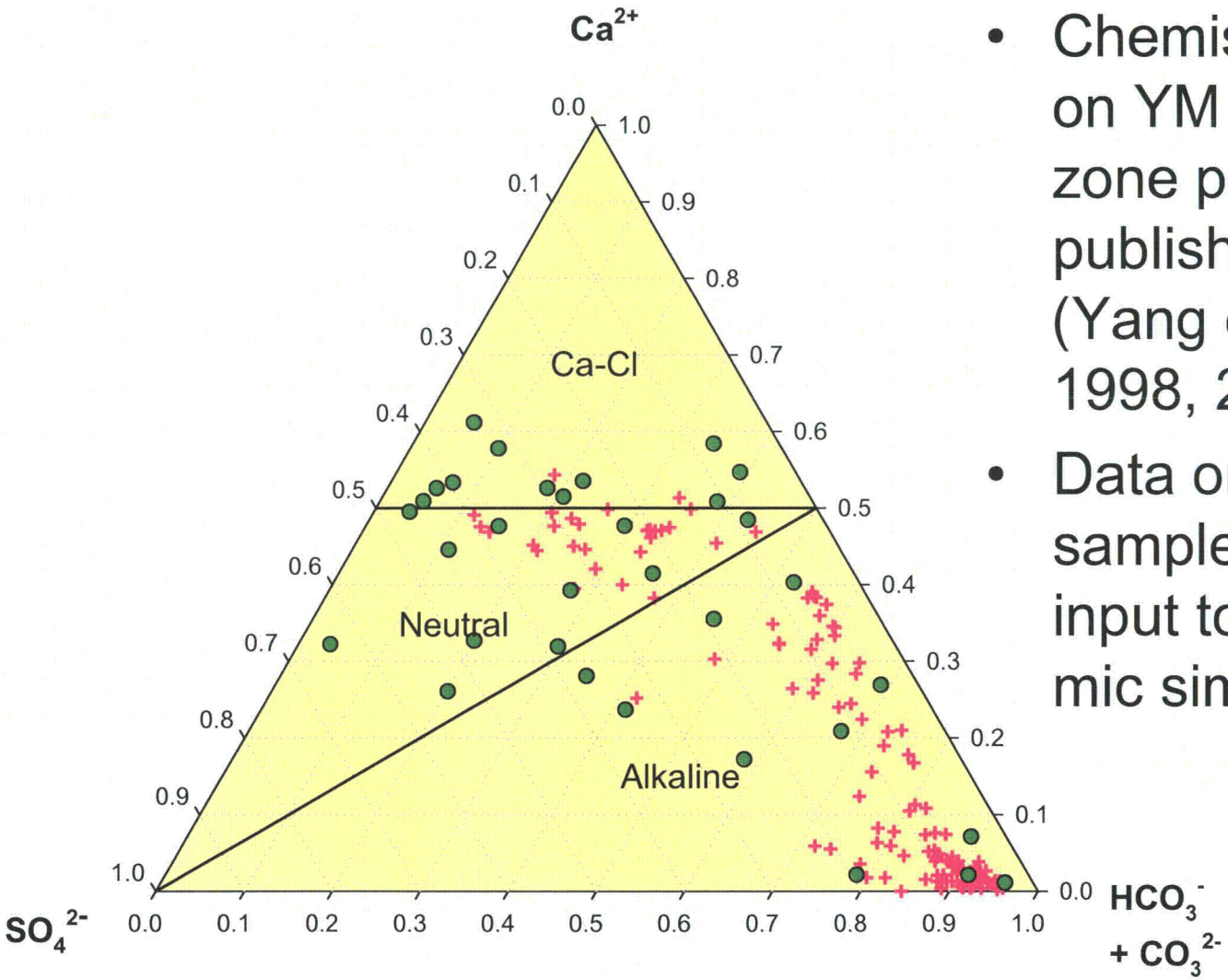
Modeling

- Thermodynamic simulations of evaporation, supplemented by chemical divide analyses, conducted to determine evolution of water chemistry
- Compositions of YM unsaturated zone porewaters belonging to three water types (calcium-chloride, neutral and alkaline) used as inputs to thermodynamic simulations

Testing

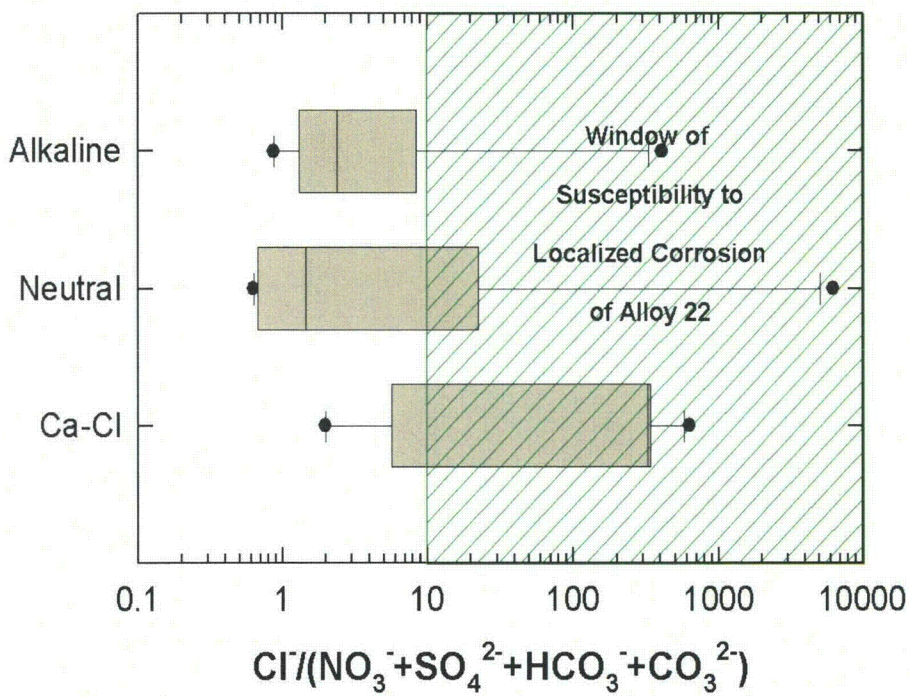
- Heater tests conducted with initially dilute calcium-chloride, neutral, and alkaline waters synthesized from reagent grade chemicals
- Deposits analyzed to determine composition and evaluate the effects on waste package container materials
- Results compared to previous tests where effects of water chemistry were systematically explored

Water Chemistry



- Chemistry data (+) on YM unsaturated zone porewaters published by USGS (Yang et al., 1996, 1998, 2003)
- Data on selected samples (●) used as input to thermodynamic simulations

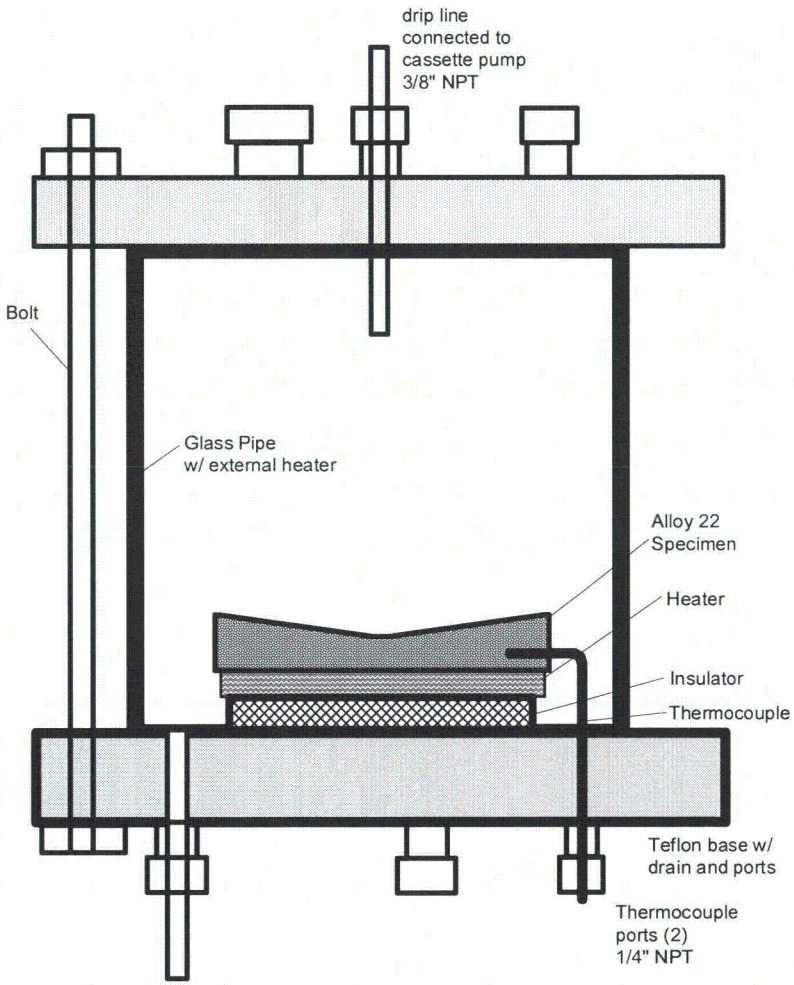
Thermodynamic Simulations



- Water chemistry after evaporation and precipitation
- Brines formed from Alkaline and Neutral water chemistries not as aggressive as brines from Ca-Cl water chemistries

Laboratory Testing

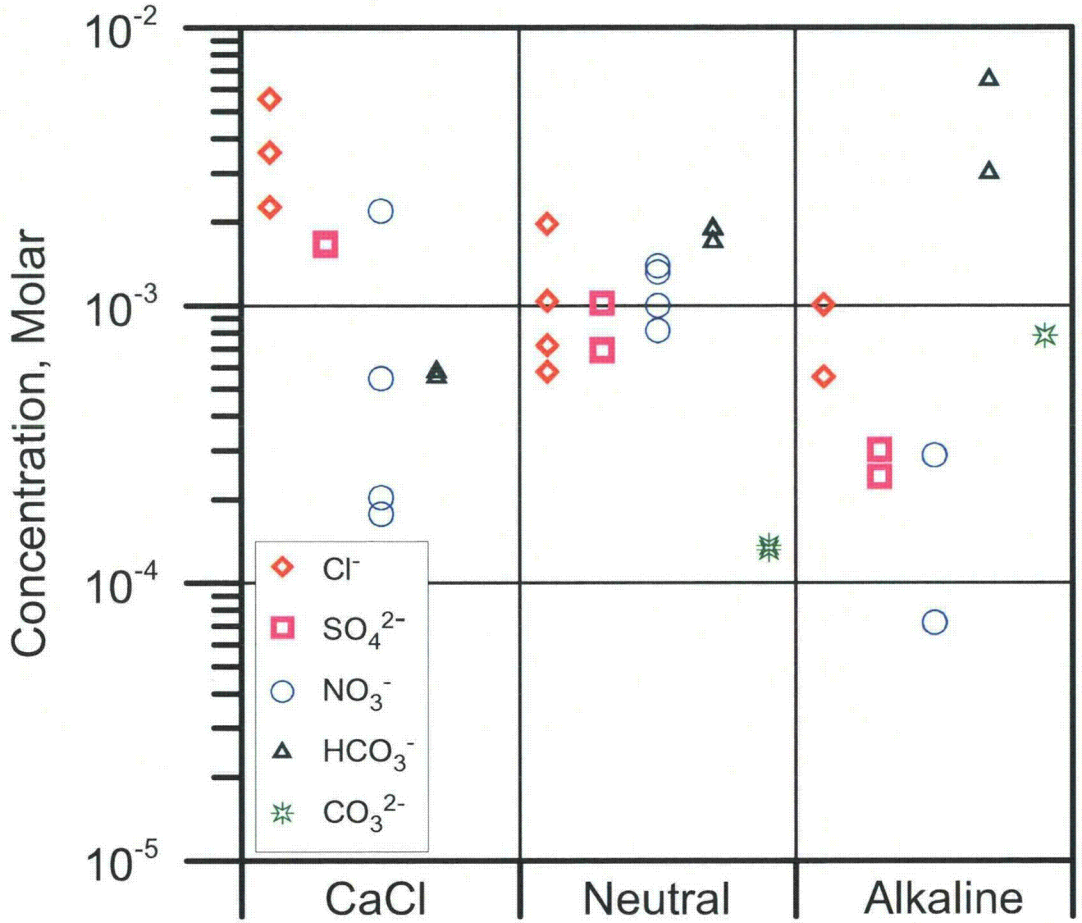
- Alloy 22 maintained at 110 °C [230 °F]
- Drip rate = 200 mL/day (one drop ~ 15 seconds)



Alloy 22 Composition

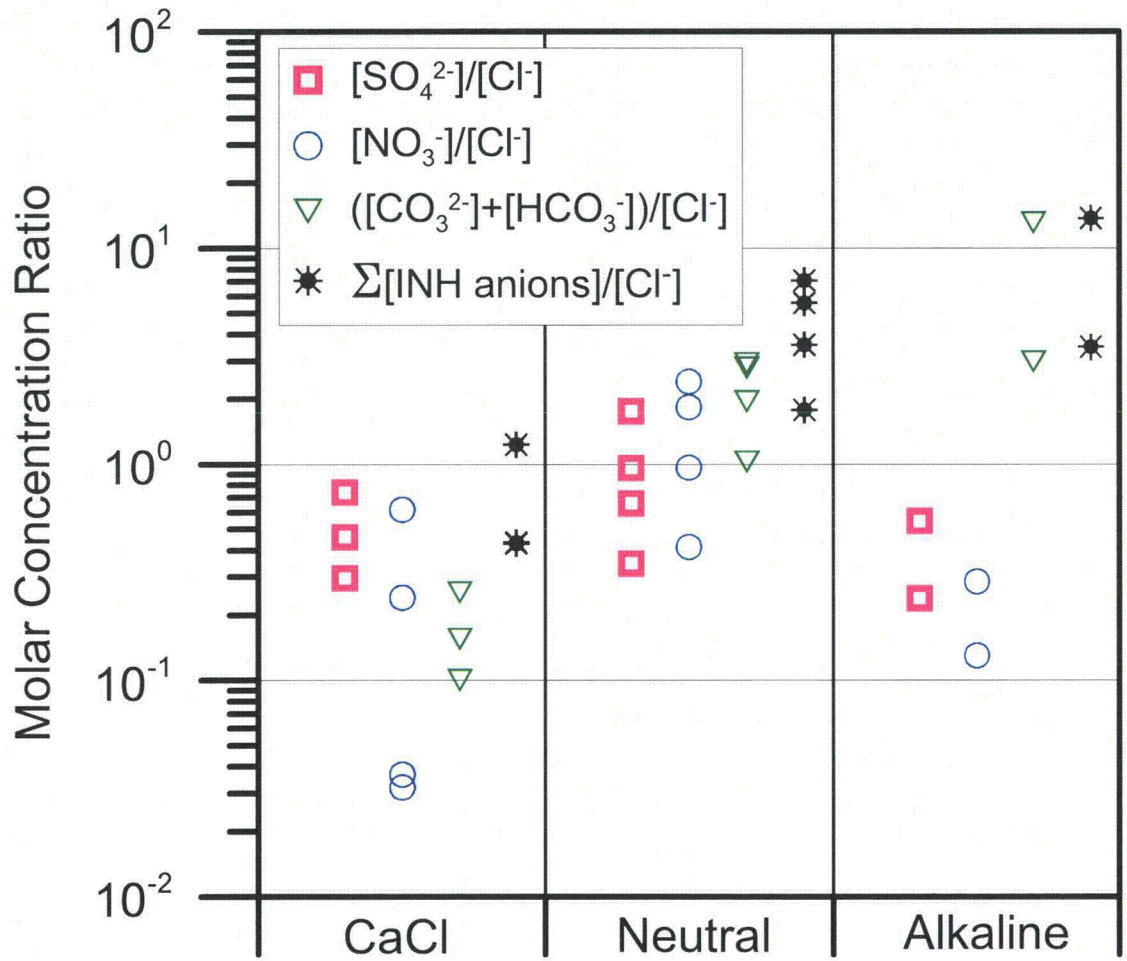
Material	Ni	Cr	Mo	W	Fe	C
Alloy 22 2277-3-3266	57.8	21.40	13.60	3.00	3.80	0.004

Test Solution Chemistry



- $[Cl^-]$ highest for Ca-Cl waters and lowest for alkaline waters
- All water compo-sitions have nitrate, sulfate, and carbonate

Test Solution Chemistry

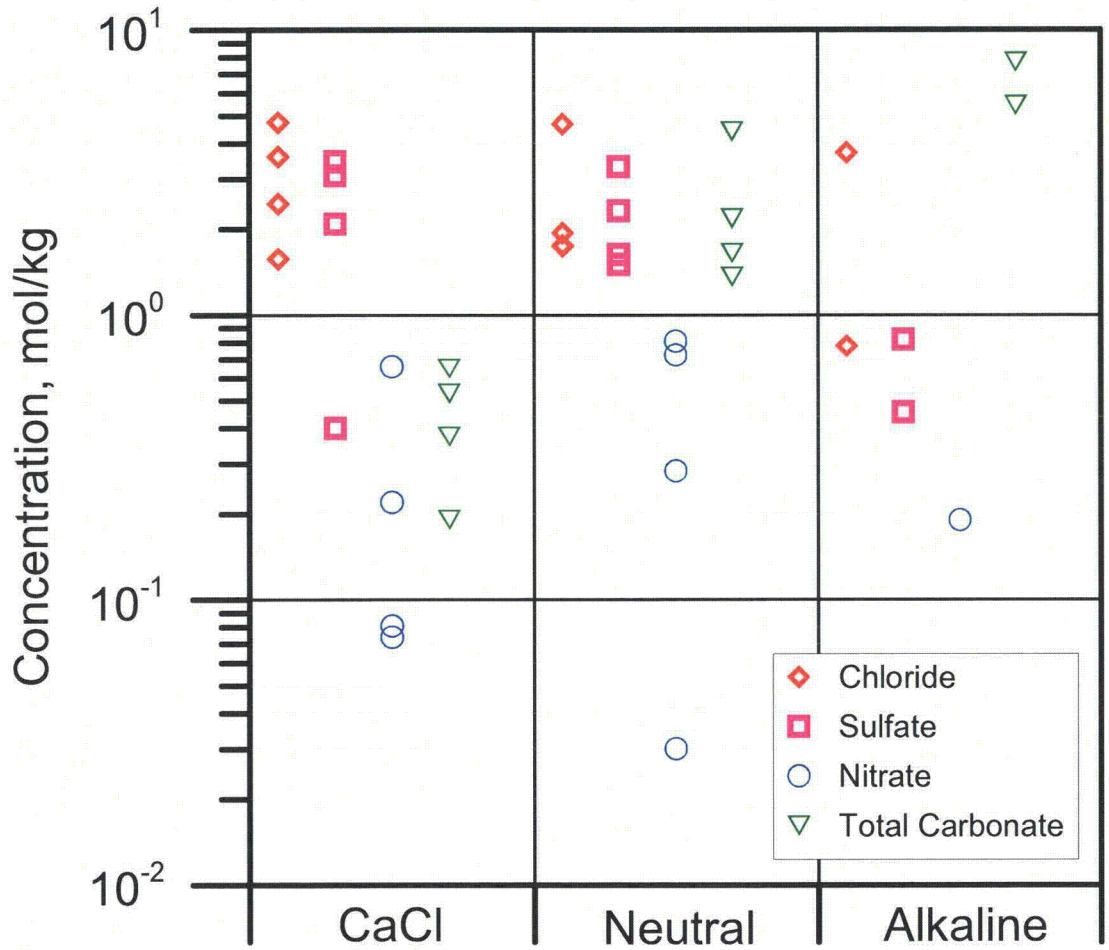


- Critical $[INH]/[Cl^-]$ previously determined to be ~ 0.1
- Inhibition possible by sulfate, nitrate, carbonate, and bicarbonate
- Chloride + bicarbonate solutions may promote SCC

Test Results

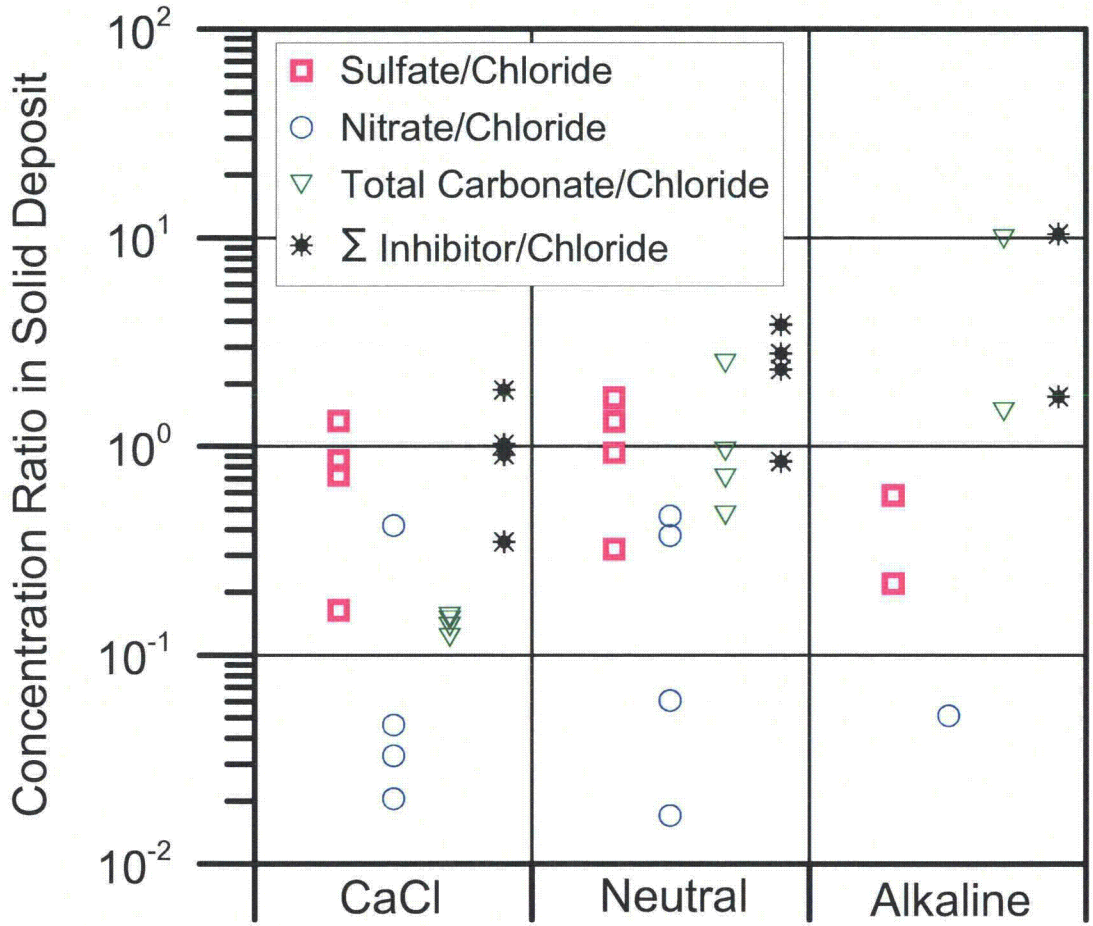
- All solutions quickly boiled and evaporated, leaving a dry salt deposit.
- No salt deliquescence observed at elevated temperature or after cooling to room temperature
- No corrosion of the Alloy 22 specimen due to salt deposition was observed

Salt Deposit Chemistry



- All deposits contained chloride, sulfate, nitrate, carbonate, and/or bicarbonate
- Salt deposit chemistry similar to starting water chemistry

Salt Deposit Chemistry



- Lower nitrate to chloride concentration ratios compared to initial solution values
- Overall concentration of inhibitors relative to chloride is retained

Conclusions

- Tests conducted using a wide range of solution compositions representative of calcium-chloride, neutral, or alkaline brines
- Formation of brines with boiling points greater than 110 °C [230 °F] was not observed
- Salt deposit composition was dependent on the composition of the initially dilute starting water
- Formation of deliquescent salt deposits or brines that promote either localized corrosion or stress corrosion cracking of Alloy 22 are not expected

DISCLAIMER

This paper was prepared to document work performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA) for NRC under Contract No. NRC–02–02–012. The activities reported here were performed on behalf of the NRC Office of Nuclear Material Safety and Safeguards, Division of High-Level Waste Repository Safety. This paper is an independent product of CNWRA and does not necessarily reflect the view or regulatory position of NRC.

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